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ABSTRACT

This document is one of six which set forth the mathematics components of the Project SEARCH Articulated Curriculum developed by the Utica (New York) City School District. Each volume deals with a broad area of mathematics and lists objectives related to that area for all grades from K through 12. Each objective listed is described first in general terms and then in terms of specific skills which students should exhibit. This volume concerns numbers and systems of numeration. The topics range from counting and recognition of numerals at the early levels to use of nondecimal systems, permutations and combinations, and interpretation of percents at upper levels. (SD)

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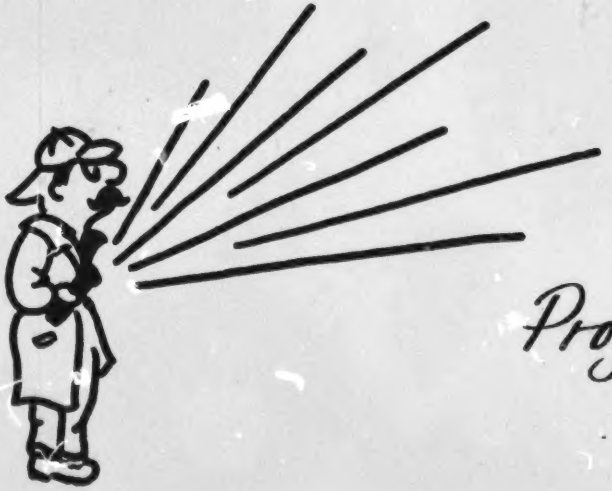
Utica City School District

Articulated Curriculum



Project Search

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FORWARD

This Articulated Curriculum is being printed and bound in this manner to provide for on-going revision. This also serves as evidence of work completed during Phase III of Project SEARCH.

MATHEMATICS

K - 12

Number and Numeration

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PROJECT SEARCH

ARTICULATED CURRICULUM

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MRS. ROSE DANELLA and NORMAN I. SIEGEL, both former Board Members deserve special mention for all their efforts on behalf of Project SEARCH.

UTICA CITY SCHOOL DISTRICT
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MATHEMATICS

NUMBER AND NUMERATION

Grade K

The student will know:	The student will:
Counting	
- the order of cardinal numbers from 1 - 10	- count orally 1 - 10
- the counting order from 1 - 10 from left to right.	- read or say the numerals 1 - 10 from left to right
- the counting order of objects 1 - 10.	- point to and count orally ten blocks.
- the cardinal number in any given set of 10 or less members.	- write the numeral for each given set of 10 or less members.
- the given sets that contain the same number of members (equivalent sets).	- draw sets of objects containing desired number.
Reading	
- the shape and name of the numerals 1 - 10.	- read the name of the given numeral from 1 - 10.
- the number concept of before and after in a series 1 - 10.	- say the number that comes before and after each given numeral from 1 - 10.
- the between-ness of a given number.	- tell the number that comes between two given numbers.
- the comparison terms large, small, largest, smallest, same, different, few, more.	- give correct term for each picture, e.g., large, small, largest, smallest, same, different, few, more.
Writing	
- the shape and order of numerals from 1 - 10 in left to right sequence.	- write or trace numerals 1 - 10 in left to right order.
- the order of cardinal numbers 1 - 10.	- write or trace numerals from 1 - 10 for each picture.

	Grade K
Writing	
- the ordinal position of an object in a given sequence 1 - 10.	- circle the desire object (first, fifth, etc.).
- the missing number in a given series 1 - 10.	- fill in the number that comes before and after a given number or write the number coming in between two numbers.
Counting	**Grade 1**
- the counting order of numbers by 1's, 5's, 10's to 100.	- count orally by 1's, 5's and 10's to 100.
- the counting order of numbers by 2's to 20.	- count orally by 2's to 20.
- the cardinal numbers to 100.	- state, select and/or write the cardinal number of a structured group to 100.
- the greater (greatest), smaller (smallest) numbers for numbers to 100.	- select which of two (or three) numbers is greater (greatest) or smaller (smallest) for numbers to 100.
- the ordinal positions to tenth.	- place an x on the object with the specified ordinal position to tenth.
- the counting of numbers on a number line.	- given a number and a number line, the student will mark its place on the number line.
Reading	
- the number words from zero to ten.	- read words orally and match words with numerals and/or structured groups.
- the reading of numerals from 0 to 100.	- given an ordered arrangement of numerals, 0 to 100, the student will read them on request from any starting point.
- the missing number in a given series of numbers.	- identify what number comes after, before or between any given numbers for numbers.

Writing

- the writing order of numerals from o to 100.
- the greater or lesser numbers in numbers to 100.
- the writing of numerals with tens and ones.
- the digits in the 10's and 1's places.

Counting

- the counting order by 10's from any starting point (limit of 500).
- the counting order by 2's from any starting point to 500.
- the differenee between odd or even numbers to 500.
- the counting order by 5's from 0 to 500 starting at multiples of 5.
- the counting order by 2's, 5's, 10's on a number line (limit of 20).

Reading

- the terms of comparison more-fewer, most-fewest (to 20).

Grade 1

- write numerals from 1 - 100 in sequential order or for an ordered set of pictures for small blocks of numbers.
- place or between two numbers to indicate the greater or lesser number, with or without structured groups, to 100.
- write the numeral which names a structured group of up to 100 objects as ___ tens and ____ ones.
- write the digit which is in the 10's or 1's place as requested for a given number and state the place value of a particular digit.

Grade 2

- be given a set that contains multiples of 10, the student will count the elements by 10's to a limit of 500.
- be given an incomplete wequence of multiples of 2, the student will supply the missing multiples to 500.
- be given a complete sequence of multiples by 2's, the student will identify odd or even numbers.
- be given an incomplete sequence of multiples of 5's, the student will supply the missing multiples to a limit of 500.
- be given a number and a number line, the student will identify same by ordinal position.

Grade 2

- be given 4 sets of objects containing unequal objects the child will mark with an x the set with the most sets to 20 (opposite terms more-fewer, most-fewest.)

Reading	
- short sequences of numbers from any starting point to 500.	- be given a number chart the student will read short sequences of numbers from any starting point to 500.
- the numbers which are one more and one less to 500.	- be given a number the student will write the numbers which are one more and one less than the given number to 500.
- the order of cardinal numbers to 500.	- be given a specific number, the student will write the cardinal numbers in order to 500.
- the number which is in between two given numbers to a limit of 500.	- - be given this sequence; numeral one, an unknown, next numeral in sequence. The student will supply the unknown. (limit of 500).
Writing	
- the cardinal number for structured groups to 500.	- be given structural groups to 500, the student will write the cardinal number, which names the group.
- the greater than or lesser than symbols (to 200)	- be given two numbers, the student will write the symbols to show which is the greater or lesser for groups to 200.
- place value - hundreds, tens, ones and in expanded notation using the + sign to 500.	- be given a number (to 500), the student will write the digit for ones, tens, or hundreds as requested.
- the place value of a particular digit of numbers to 500.	- be given a number to 500 the number (digit) for ones, tens, or hundreds as requested, the student will write the digit which is in the unit's tens or hundreds place.
- the digits in columns according to place value, (tens, hundreds and ones).	- be given numbers to 500 the student will write the digits in columns according to place value.
- the Roman numerals to XII. (Introduction)	- be given a Hindu - Arabic numeral, the student will write its equivalent in Roman numerals from 1 to 12.

Counting	Grade 3
- the cardinal numbers from 1 to 1,000.	- be given sets around the room, outdoors, the student will identify the number in each set.
- the ordinal numerals.	- be given sets of concrete objects, the student will identify the position of an element in the set.
Reading	Grade 3
- the reading of the sequence of numbers from any starting point to 1,000.	- be given a chart of 1 to 1,000, the student will be able to read a series of numbers in sequence from one starting point to another.
Writing	
- - the writing of the sequence of numbers from any starting point from 1 to 1,000.	- be given an incomplete number line with starting and ending numbers identified, the student will fill in the missing numerals.
- number words to an including 4 place numerals.	- read, write and use number words from 1 to 1,000.
- the Roman numerals from 1 to 100.	- read and write Roman numerals from 1 to 100.
- expanded notation up to and including 4 place numerals.	- be able to read and write expanded numbers.
- skip-counting up to 1,000 (backward and forward)	- be given the multiple, the student will be able to recite and write series up to 1,000 e.g., 2's, 3's, 4's, 5's, etc.
- the inequality symbols up to 1,000.	- be given the numerals, the student will read, write and provide correct inequality symbols up to 1,000 (on 4 place numbers).
Counting	Grade 4
- the counting order to 1,000,000 starting at any	- be given a specific number, e.g., 10,986, the child will orally count to another specifically given number, e.g., 11,175.

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	Grade 4
Counting	
- the counting order by tens starting at any point.	- be given the number 7,000, the child will count by ten's to 7,500.
- the counting order by 2's, 3's, 4's and 5's to 1,000,000 starting at any point.	- be given a specific starting point, the child will count by 2's, 3's, 4's, 5's, to another given number.
Reading	
- the numerals to 1,000,000 starting at any point.	- be given a specific list of numbers, the child will be able to read the list.
- the Roman numerals from one to one thousand	- be given a specific list of Roman numerals, the child will be able to read the corresponding Arabic numeral to 1000.
- the symbols for less than ($<$) and greater than ($>$) and their place in numbers to 1,000,000.	- be given two specific numbers, the student will be able to place the greater than or less than symbols between.
- the identification of place value digits to 1,000,000.	- be given a specific number, the student will be able to orally identify the place value of each digit.
- the odd and even numbers up to 1,000,000.	- be given a random list of numerals between 1 and 1,000,000, the student will circle the even numerals.
Writing	
- the expanded notation, words/numbers and "+" signs of numbers to 1,000,000.	- be given an abacus representing any given numeral from 1 to 1,000,000, the student will be able to write the numeral correctly, and vice-versa.
- the number words of numbers to 1,000,000.	- be given a list of words representing numerals from 1 to 1,000,000, the student will be able to write them by number words and vice-versa.
- the numerals to 1,000,000 starting at any point.	- be given a specific number orally, the student will write the number. (1 to 1,000,000).

	Grade 4
Writing	
- that commas show place value in large numbers and are grouped by threes.	- be given numbers of 6 to 9 digits, the student will separate each group of three by the use of commas starting from right to left.
- the process of rounding off numbers to the nearest 10's, 100's, and 1,000's for comparison and estimating answers.	- be given a specific number, e.g., round off 198 to to nearest 100, the child will round off numbers to nearest 10,000 or 1,000.
- the Roman numerals up to one thousand.	- be given a specific number of Roman numerals, the child will write the corresponding Arabic numerals and vice-versa.
Counting	**Grade 5**
- counting from any number by 2's, 3's, 4's, through 10.	- be given a starting number the student will count by 2's, 3's, 4's through 10.
Reading and Writing	
- the prime numbers 1 - 100.	- write a definition of prime number and write the prime numbers 1 - 100.
- the ordinal numbers from 1 - 100.	- write the definition of ordinal number and write the ordinal numbers 1 - 100.
- factors of 1 - 12.	- write the definition of the meaning of factor, name the operations involved, construcat a grid of factors 1 - 12, and recite given multiplication facts.
- Roman numerals to 1,000.	- identify (name) Roman numerals presented on oak tag strips or on board, write the Roman numerals in multiples 5 - 100, and write the Roman numerals in multiples of 100, to 1,000.
- the basic laws of commutativity, associativity, distributivity.	- write a definition of each law e.g., commutativity, associativity, distributivity; write an operation involving each term; and identify each law from examples given.

	Grade 5
Reading and Writing	
- the reading and writing of numerals up to 1,000,000,000.	- be given several numbers orally, the student will write them.
- how to round numbers to 1,000,000.	- round given numbers.
- the different periods and what they represent.	- be given written numbers, the student will identify the period designated.
- expanded notation.	- be given a standard numeral, the student will write it in expanded notation.
- the concept of negative whole numbers.	- be given a thermometer, the student will read and write temperatures below zero.
Counting	**Grade 6**
- the base 10 number system is a positional system.	- be given numbers to 1,000,000,000, the student will identify place value.
Reading	
- that our number system is a positional one.	- be given numbers to 1,000,000,000, the student will read them.
- the Roman system is non-positional with additive and subtractive patterns.	- be given Roman numerals, he will read them using symbols I, V, X, L, C.D, M.
- the prime and composite numbers.	- be given numbers, students will test to determine if it is prime or complete.
- the symbols $>$ and $<$.	- be given number sentences involving symbols, students will label as true or false.
Writing	
- that a number may be approximated or rounded to a more practical or convenient number.	- be given numbers, student will write them in their rounded form to 10's, 100's and 1,000's using up to a 6-digit numeral.

Writing	Grade 6
- that an exponent tells how many times a base number is used as a factor.	- be given numbers, he will write them in their exponential form.
- that our number system is a positional one.	- be given numbers to 1,000,000,000, student will write them in numeral and word form.
- that a bar indicates multiplication by a thousand when working with Roman numerals.	- using the bar, the student will write Roman numerals.
- that other base systems exist which are positional like base 10.	- be given numbers, students will write them in base 5 and base 2, and change them from base 5 and base 2 to base 10, vice-versa.
- expanded notation to 100 billion.	- be given 12 digit number, student will use expanded notation.
- the GCF of a pair of numerals.	- be given a pair of numerals, student will determine factor sets to find common factors and the GCF.
	Grade 7 - 8
- that a system of numeration is used to name numbers.	- show, by the use of a tallying system, different numbers and symbols.
- the Roman and Egyptian Numeration System.	- write Roman and Egyptian Numerals. - read Roman and Egyptian Numerals. - create his own Number system.
- the Hindu-Arabic or Decimal system of	- write any number in this system by using: 1. zero, as a place holder 2. the idea of place value.
- the concept of Place Value	- write the pattern of the Place Values as powers of Ten and the decimal places as well.
- the concept of Cardinal and Ordinal numbers	- show that Cardinal numbers are used to tell how many.

Grades 7 - 8

- that in forming numerals we write the digits in groups of three (periods), separated by commas for convenience in Reading.	- read numbers of any magnitude.
	- write numbers of any magnitude.
- the concept of writing numerals in expanded notations.	- write numbers in expanded notation.

Grade 9

- What a fraction represents.	- draw physical representations of fractional numbers.
- The meaning of equivalent fractions	- draw physical representations equivalent fractions.
- Decimal place value	- read and write decimal numbers.
- The relationship between fractional numbers and decimals.	- Rename fractional numbers as equivalent decimal numbers and vice versa.
- The meaning of per cent.	- Draw physical representation of "per cent".
- The relationship between a per cent and a fraction.	- Rename fractions as per cents and vice versa.
- The relationship between a decimal and a per cent.	- Rename decimals as per cents and vice versa.
- The rules for order of operations.	- Solve a numerical problem which involves more than one basic operation and grouping symbols.
- How to find the square root of a number through a mathematical solution.	- Find the square root of a number.
- How to round-off a number to correct place value.	- Round-off a number to a given place value.
- The rules for order of operations.	- Solve a numerical problem which involves more than one basic operation and grouping symbols.

	Grade 9
- How to find the square root of a number through a mathematical solution. - How to round-off a number to correct place value.	- Find the square root of a number. - round-off a number to a given place value.
	Grade 9 = 12
- That digital computers use the base 1 system.	- Convert a base two number to a base 10 number and vice versa.
- That a computer is composed of an input, output, arithmetic, logical, control and memory unit.	- List in writing the component parts of a computer.
- That the component parts of a computer are interrelated.	- Draw the interrelationship of the component parts and describe in writing the function of each component part.
- That some computers, such as Monroe, use the Octal system rather than the binary system for storing information.	- Convert a base 2 number to a base 8 number and vice versa.
	Grade 10
- The meaning of ratio and proportion .	- compute the mean proportion given the extremes of the proportion.
	Grade 10 - 12
- The Decimal Numbers	- a. read given decimal numbers. b. write given decimal numbers c. convert decimals to fractions. d. convert fractions to decimals
- The Common Multiples	- a. calculate the least common multiple b. calculate the greatest common divisor c. factor a given number.

	Grade 10 - 12
- The Prime Numbers	- a. factor a given number into primes b. draw a factor tree
	Grade 11
- The structure of the real number system through complex numbers.	- a. compare the relationships among the various sets of numbers which make up the set of reals. b. plot a complex number on complex plane.
-The postulates of a number field.	- a. list the postulates of the number field. b. recognize which postulates are or are not satisified by the various number sets.
- The operations on numbers in specified sets.	- factor expressions using common factors, difference of two squares, quadratic trinomial (including perfect square trinomials $(4x^2 \quad 4x - 3)$.
- The operations on fractions.	- a. perform the four fundamental operations on fractions. b. simplify complex fractions.
- The operations on real numbers involving exponents and radicals.	- perform and simplify exponentials and radicals.
- The operations on complex numbers.	- apply the postulates of the number field to complex numbers.
	Grade 11 - 12
- Factorial notation.	- evaluate a factorial $4! = 4 \cdot 3 \cdot 2 \cdot 1 = 24$.
- The formula for permutations of n things taken r at a time.	- evaluate a formula for permutations of n things taken r at a time. $5 P 2 = 5 \cdot 4 - 20$
- The formula for combinations of n things taken r at a time.	- evaluate a formula for the combination of n things taken r at a time $\binom{5}{2} = \frac{5 \cdot 4}{2 \cdot 1} = 10$

- The difference between permutations and combinations.	- differentiate between a permutation and a combination in a given problem.
	Grade 12
- the meaning of "Binary Coded Octal"	- convert normal decimal count to the base eight (8) counting system. a. emphasis is to be placed on decimal place (position) value in base 10 system. b. emphasis is to be placed on octal place (position value in base 8 system. c. emphasis is to be placed on binary place (position) value.
	- utilize information in (1) (a), (b), (c) above, and convert a number expressed in the base 8 system to binary coded form (base 2).
	- utilize information in (1) (a), (b), (c) above, and convert a number expressed in the base 2 system to octal coded form (base 8).
- The needed approach to computer programming, i.e. "program format" as it pertains to planning a computer program.	- learn and use unique binary coded octal instructions that represent mathematical operations. - correlate several binary coded octal instructions into the correct format such as to represent a known formula, needed in problem solving.
- The binomial expression	- expand the binomial $(2x - \frac{1}{3})^7$ - evaluate an expression using the factorial notation.
- the sum, the recursive definition, the n-th term definition of series and sequences and the formula for the n-th term and sum of a series and sequence.	- write a sequence using the recursive definition. - write a sequence using the n-th term definition. - compute the n-th term or sum of a given series

- The structure of the set of real numbers	- Prove that 2 is irrational.
- The structure of the field of complex numbers.	- prove the communitive and associative properties for the field of complex numbers using definition of addition and multiplication by ordered pairs.
- The techniques needed to change from logarthmic to exponential notation, and reverse.	- change equations from logarithmic notation to exponential equation, and reverse.
- The techniques needed to change from one logarithmic base to another.	- change equations from one logarithmic base to another.
- The use of natural logarithmics.	- compute problems using base e.
- The conversion from revtangular to polar coordinates, and reverse.	- convert rectangular to polar coordinates, and reverse.